BACTERIOLOGY FOR NURSES*

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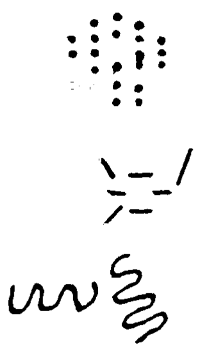
(2) According to the materials which they live on:

1. *Saprophytic.* That is, those which live on *dead* animal matter, causing putrefaction and fermentation in it. Most bacteria belong to this class, which changes the bodies of dead animals into a condition suitable and necessary for the supply of food for the vegetable or plant kingdom, which we heard about from Pasteur in describing Nature's Food Cycle.

2. *Parasitic.* Those which live at the expense of the living tissues of the animal and vegetable kingdoms. Most of the organisms which have been found to cause diseases belong to this class and are called pathogenic, or disease-producing bacteria.

(3) According to their shape or morphology:



1. *Cocci* (coccus, a berry). Round, spherical, like a billiard ball.

2. *Bacilli* (bacillum, a rod). Rod-shaped, lead-pencil shaped.

3. *Spirilla* (spirillum, a small coil or spiral). Cork-screw shaped.

Special names are preferred to any of the above according to their grouping—*e. g.*, cocci arranged in pairs are called diplococci; in chains streptococci and in groups like a bunch of grapes staphylococci. The same bacilli placed end to end in a chain are called streptobaccilli.

In our definition of bacteria, the word microscopic was used on account of their minute size, distinguishable as individual bodies only by means of the microscope. Their measurements vary, but the diameter of some cocci has been calculated to measure $\frac{1}{150000}$ inch; the length of bacilli to be $\frac{1}{25000}$ to $\frac{1}{4000}$ inch; and spirilla up to $\frac{1}{600}$ inch.

Special processes have divulged the fact that certain organisms have little hair-like tails or flagellæ which wave about and cause active movements in the bacteria, which quality is called motility.

Many bacteria have the power of elaborating certain poisonous chemical products, called toxins, which we will find later are responsible for many of the symptoms of disease.

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How do the bacteria grow and increase?

1. By fission or division into two. The rapidity with which bacteria might increase in this way is almost inconceivable. If a bacillus divided once an hour, at the end of 24 hours there would be 16,500,000 and in 3 days their weight would be 17,500 tons. Fortunately the conditions necessary for such rapid growth are never present, so that such an alarming number as mentioned is an impossibility; still, although one organism is extremely minute by itself, it is easy to imagine the enormous power when present in great numbers.

2. By spore or seed formation. Certain bacteria possess the power of entering this seed or spore stage, in which they remain until they meet with favorable conditions for growth. A spore begins as a small bright point in an organism (for example, say a bacillus) and gradually increases to a considerable size; the bacillus about it gradually withers and disappears, leaving the spore as a bright, highly refractile body. Spores never increase by fission, but remain in their seed state until they are planted on a favorable soil, when they develop into the organism from which they were formed in the first place, multiplication occurring then by the process of transverse division. It is as spores that saprophytic bacteria exist in the living animal tissues. As soon as the animal dies, its dead tissues enable the spore to develop into their active form, in which they rapidly increase by fission and produce the putrefaction and fermentation which invariably occurs. It is important to remember that spores are very resistant to the action of heat and disinfectants.

What conditions are necessary for the growth of bacteria?

1. Temperature. That at which most bacteria grow is 98° F. They can exist in a temperature as low as 32° F. or as high as 170° F. Greater heat than 170° F. kills them.

2. Moisture. This is essential to the growth of bacteria.

3. Air. It is the oxygen in the air which some bacteria require for their growth, on account of which they are termed *aërobic*. Others, however, will only grow when free from oxygen and are called *anaërobic*.

4. The presence of some form of organic material.

In what places are bacteria found?

1. Everywhere that dust is present, such as on and in the earth, having been found down to the depth of 9 feet. There are none on the Arctic glaciers and very few in mid-ocean.

2. On the surfaces and in the mouths, throats and digestive tracts of human beings and animals.

3. In water, milk, and in many foods and liquids.

In many of these places the bacteria remain dormant and do no harm, only becoming active and increasing in number when they meet with the above conditions for growth.

Media.—Bacteriologists have learned how to supply the conditions under which bacteria will grow most rapidly. The organic material is supplied in a number of different forms, called media, those in everyday use in the bacteriological laboratory being bouillon or clear soup; agar-agar, made from sea-weed; gelatine. blood-serum, milk or potato. These media are rendered free from living organisms by subjecting them to heat above a temperature of 170°, called sterilization.

The media contain the moisture necessary for growth and are prepared in glass test-tubes plugged with cotton-batting so that no air is allowed to come in contact with them. They are placed in an incubator or oven, which is kept at a constant temperature of 98° F.

The process of examination of an organism by a bacteriologist will be comprehended most readily by following him through the steps of examining for the organism which produces diphtheria.

The bacteria are swabbed from the patient's throat, by means of an applicator covered with a pad of absorbent cotton. This swab, as it is called, is smeared on the surface of the media, usually blood-serum in the test-tube, thus planting some of the bacteria on a favorable soil for growth. This inoculated tube of blood-serum is placed in the incubator at a temperature of 98° F., where the bacteria increase and multiply from 12 to 24 hours. They are then prepared for examination under the microscope by smearing some of them on a glass slide or cover-slip, drying them over a gas flame and staining them with special stains used for the purpose. The characteristic shapes of the different bacteria can then be distinguished under the miscroscope. Some of the bacteria commonly met with are:

1. Pus-producing bacteria.

A. Staphylococcus Pyogenes Aureus. You have already heard that cocci arranged like a bunch of grapes are called staphylococci; pyogenes refers to an organism that has the power of producing pus; and the term aureus applies because a mass of these organisms growing together have a golden color.

B. Staphylococcus Pyogenes Albus. The first two characteristics are similar to *A.*, but their color is white instead of golden.

C. Streptococcus Pyogenes. This organism is one in which the individuals are arranged in a chain and which produces pus.

These three organisms are the cause of most of the suppuration which occurs in wounds.

2. Tubercle Bacillus. The results of the action of this germ are seen in the terrible suffering and distress of a person with tuberculosis, or consumption, as it is called, when the lungs are the principal seat of disease. Many of the bone-and-joint diseases, such as hip-joint disease, Pott's disease of the spine and tubercular knee or ankle are also caused by it.

3. Klebs-Loefleur Bacillus. By being inhaled with the air or taken in with the food, this organism comes in contact with the throat and produces diphtheria.

4. Diplococcus Pneumonial. Pneumonia is caused by it.

5. Bacillus Typhosus. This acts on the intestines and typhoid fever occurs.

6. Bacillus Tetani. This is the most deadly of all bacteria. It produces lock-jaw and convulsions when it gets into the system through a wound.

7. Diplococcus Intracellularis Meningitides. Cerebro-spinal meningitis, of which we have been hearing so much lately in the daily press, is due to this organism. An analysis of the name may help you to comprehend its meaning. The cocci are arranged in pairs (diplococci) within a shell or capsule (intra cellularis), and it causes meningitis (hence meningitides).

How do bacteria get into the system of the human being?

1. *Through the skin or mucous membrane.* When intact these resist the entrance of all bacteria, but the moment there is a break in the surface, such as a cut or scratch, these microscopic organisms are liable to enter the system. Prominent surgeons have lost their lives from blood-poisoning which followed the entrance of some deadly organism through such an insignificant opening as the prick of a needle. We cannot, therefore, be too careful to keep our hands as free from small cuts and abrasions as possible and to disinfect any which may be present after contact with cases in which there is pus.

2. *Through the respiratory or breathing passages.* In this way is inhaled that dreaded organism the tubercle bacillus, which slowly eats away the lungs and causes that hacking and irritating cough, the thin hollow cheeks and the slow life in death, which but few of you have not seen. Pneumonia, influenza and other lung diseases result from the entrance of the organisms in this way.

3. *Through the digestive tract.* Food containing bacteria is swal-

lowed and passes down into the intestines, where the bacteria grow, producing some form of intestinal disease, the commonest example of which is typhoid fever.

As it is inevitable that a great many organisms enter our bodies, we have been provided with certain powers of resisting their action and of eliminating them from our systems. Among the ways in which this is carried out are the following:

A. *By matter or pus,* which results in a wound from the fight between the bacteria and the tissues and in which are washed away many bacteria when the wound is dressed.

B. *By expectoration,* by which bacteria are carried out of the lungs and throat.

C. *By the excretions,* the fæces containing many organisms from the intestines, and the urine those from the kidney and indirectly from the blood.

How do bacteria produce disease after they have gained entrance into the systems?

1. *Mechanically.* Occasionally, bacteria may increase rapidly in the blood-stream and form clumps which plug the smaller blood-vessels or capillaries. This, however, rarely occurs.

2. *By using up the supply of nourishment for their growth,* which ordinarily would supply the tissues of the body. In this way the latter are starved and they consequently undergo marked change, wasting, as they do in all forms of tuberculosis.

3. *By elaborating certain poisons or toxins,* which act either on the tissues locally or on the system generally and produce the characteristic symptoms of the disease. These symptoms, such as the rash, cough, and sore throat, help us to recognize the disease which is present, being fairly constant when produced by a certain toxin of a certain organism. Their severity may vary, however, according to the virulence or strength of the toxin produced, so that we may have what is called either a mild or a severe attack of the disease.

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